Appendix M

Adoption Task 2: Implications of NGSS Shifts for Educators and Students from Achieve and U.S. Education Delivery Institute

The NGSS authors have defined six conceptual shifts that the standards require for faithful implementation:

- **K–12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real world.** Most state and district standards express the three dimensions as separate entities, leading to their separation in both instruction and assessment. The NGSS expectations for both students and teachers are that they will engage at the nexus of these three dimensions, applying practices to content knowledge and making use of crosscutting concepts to do so.

- **The NGSS are student performance expectations — NOT curriculum.** The disciplinary core ideas themselves form a progression of knowledge for students that are clearly laid out in the NGSS, but the science and engineering practices and crosscutting concepts should not be limited to specific time periods of instruction. Rather, educators and students should return to the science and engineering practices and crosscutting concepts again and again, applying them to every disciplinary core idea so that content knowledge progression is accompanied by skill development in the application of scientific practices and concepts. Simply said, the NGSS form the basis for student performance. Curriculum materials are state and local decisions that will encompass the order and day-to-day instructional needs to prepare students for the performances.

- **The science concepts in the NGSS build coherently from kindergarten through grade 12.** The focus on a few disciplinary core ideas is a key aspect of a coherent science education. Historically, science education has been taught as a set of disjointed and isolated facts. The NGSS provide a more coherent progression aimed at overall scientific literacy, with instruction focused on a smaller set of ideas but with an eye on what the student should have already learned and what he or she will learn at the next level. These progressions for each grade band assume that the necessary previous material has been learned by the student.

- **The NGSS focus on deeper understanding of content as well as application of content.** Within the disciplinary core ideas, the focus of the NGSS is on conceptual understanding — not just the facts that are associated with them. The facts and details are important evidence but can no longer be the sole focus of instruction. *A Framework for K-12 Science Education* casts this shift in terms of the difference between novices and experts: “Experts understand the core principle and theoretical constructs of their field, and they use them to make sense of new information or tackle novel problems. Novices, in contrast, tend to hold disconnected and even contradictory bits of knowledge as isolated facts and struggle to find a way to organize and integrate them.” The NGSS aim to make students experts rather than novices.

- **Science and engineering are integrated in science education from kindergarten through grade 12.** Unlike the traditional science disciplines, engineering has not routinely been included in state science standards, curricula or assessments or as a component of the education of new science teachers. The NGSS integrate engineering into the structure of science education by raising engineering design to the same level as scientific inquiry in classroom instruction and by giving core ideas of engineering and technology the same status as those in other major science disciplines.
- **The NGSS make explicit connections to the CCSS (English language arts/literacy and mathematics).** The release of the NGSS comes as most states are implementing the CCSS. This creates an opportunity for science to be part of a child's comprehensive education. The NGSS take into account the content and performance expectations of the CCSS to ensure a symbiotic pace of learning in all content areas and specifically refer to related standards in the CCSS.

Shift	Questions To Consider
K–12 science education reflects the real-world interconnections in science.	• What do our current science standards require with respect to this shift (i.e., what is our baseline)? • Do our current science standards require students to demonstrate understanding by applying specific scientific practices and crosscutting concepts to core content knowledge and its acquisition? • Do our science educators emphasize this application in their expectations, instruction and assessment of students? • Do our schools and support systems facilitate collaboration among science educators to demonstrate the reach of scientific practices and crosscutting concepts across the core ideas in the disciplines? • Do we have a plan to ensure that our statewide summative science assessments are aligned to the NGSS?

All practices and crosscutting concepts are used to teach core ideas all year.	• Do our current science standards require students to build skills in science and engineering practices and crosscutting concepts by focusing on them — and connecting them to content — throughout each school year? • Do our science educators teach science practices and core concepts as a progression of core content rather than in addition to it? Do they use these practices and concepts to build in-depth student understanding in the context of the content areas covered throughout the school year? • Do our schools and support systems equip and encourage educators to plan their lessons in this way? • Do schools and teachers have access to the consumable physical materials (beyond textbooks/curriculum materials) to prepare and execute the classroom investigations and design work required by the NGSS?
Science concepts build coherently across K–12.	• Do our current science standards lay out expectations for student scientific knowledge as a progression across grades, or do they expect the same content (or unrelated content) to be taught across multiple years? • Do our science educators treat science content as a cumulative body of knowledge built year by year? Can they assess students' prior knowledge and take appropriate remedial action? • Do our schools and support systems emphasize the collaboration of educators across grade levels to ensure this progression of knowledge for their students?
The NGSS focus on deeper understanding and application of content.	• Do our current science standards expect students to master scientific core ideas and principles (e.g., "molecules are made up of atoms, and have different properties depending on their combination") and use them in multiple contexts, rather than memorizing particular facts or details with little or no context (e.g., "the molecule CO, carbon monoxide, is a poisonous gas")?

	• Can our science educators emphasize a deep understanding of core ideas, sometimes at the expense of particular details associated with those ideas? • Do our schools and support systems give educators what they need to keep coming back to and focusing on these disciplinary core ideas?
Science and engineering are integrated in science education from kindergarten through Grade 12.	• Do our current science standards require students to use engineering design ideas and practices alongside the traditional science disciplines from kindergarten through Grade 12? • How comfortable are our current and candidate science educators with engineering design? Do they raise it to the same level as scientific inquiry as a core practice in science instruction? Do they give core ideas of engineering and technology equal weight with those in other disciplines? • Do our schools and support systems prepare our educators to teach engineering design and the core ideas of engineering and technology? Is this reflected in policy/funding for course offerings and their content?
Science standards coordinate with the CCSS in English language arts/ literacy and mathematics.	• Are our current and candidate science teachers aware of and knowledgeable about the CCSS? • Do our schools and support systems allow and encourage collaboration across scientific and nonscientific disciplines in the teaching of literacy, numeracy and science?